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(54) IMPROVEMENTS IN OR RELATING TO FIELD EMISSION ION SOURCES

(71) We, UNITED KINGDOM ATOMIC ENERGY AUTHORITY, London, a British Authority do hereby declare the invention,

for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to field emission ion sources.

Field emission ion sources are devices in which ions are emitted from points of small radii of curvature under the influence of very high electric fields which are produced at such points when a potential difference is applied between the points and an adjacent electrode.

Such sources can be used for obtaining information about the structure of the material of which the emitting points are made, as sources of ion beams for such purposes as ion implantation into a substrate material, or as thrusters for use with artificial satellites to maintain them in a desired orbit or orientation.

According to the invention there is provided a field emission ion source, comprising an array of emitting points, a reservoir for a liquid source material for ions to be emitted, and a plurality of capillary feed channels for supplying the liquid source material to the emitting points.

Preferably the array of emitting points is a linear array of pointed wires and the capillary feed channels are provided by the interstices between the wires.

Alternatively a thin metal blade, such as a razor blade, can be etched to provide the array of emitting points, and the capillary feed channels can be provided by grooves etched into the metal blade.

For some purposes where it is not desired that the ion source should operate for any great length of time, the total volume of the capillary feed channels may provide a sufficient reservoir of liquid source material.

An embodiment of the invention will now be described, by way of example, with reference to the drawings accompanying the provisional specification, in which:—

Fig. 1 shows a representation of part of an array of wires for use in the invention, and

Fig. 2 is a representation of an embodiment of the invention.

Referring to figure 1, a linear array 1 of emitting points 2 for use in a field ion emission source consists of a plurality of tungsten wires 3 which are of some 2 thousandths of an inch in diameter and are etched to provide emitting points 2 at one end. The wires 3 are joined together by a web 4 of vapour deposited tungsten of less thickness than the wires so as to provide a coherent body having an array of emitting points 2 along one edge and a plurality of grooves 5 along which liquid ion source materials can be fed by capillary forces to the bases of the emitting points 2. The final transport process is via a surface film which forms over the surfaces of the emitting points 2. Alternatively, the wires 3 can be brazed together.

The material out of which the wires 3 are made must be such as not to be corroded by the ion source material. For use as a source of alkali metal, specifically caesium, ions tungsten or a nickel-chromium alloy are suitable.

Referring to figure 2, a field ion emission source consists of an array 1 of emitting points 2 such as that described with reference to figure 1, clamped between two stainless steel plates 21 and 22. The plates 21 and 22 are held together by means of a series of nuts and bolts 23. The gap between the plates 21 and 22 is sealed by means of a gasket 24. In the plate 22 there is a hole 25 of some 5/16 of an inch in

diameter. The hole 25 is filled with a plug 26 of porous metal or alloy and, together with the space enclosed between the plates 21 and 22, forms a reservoir for the liquid ion source material. The spaces between the intersticial web 4 and the plates 21 and 22 provide a plurality of capillary feed channels 27 along which the liquid source material can pass under the action of capillary forces to the bases of the emitting points 2. The plug 26 acts as a wick and controls the rate of feed of the liquid ion source material to the capillary feed channels 27 independently of gravity or hydrostatic feed pressure.

Of course, the plates 21 and 22 can be joined together by other standard techniques such as welding or brazing. In this case, the gasket 24 is unnecessary.

In order to prevent the preferential emission of ions from the ends of the array, due to the enhancement of the operating electric field at the ends of the array, the radii of curvature of the wires at the end of the array can be increased relative to those of the rest of the array, by heating the appropriate wires.

In use the ion source can be operated in conjunction with an extractor electrode to which there is applied an operating voltage commensurate with the ionisation potential of the source material; for caesium this voltage is about 2 kV. It may be necessary to heat the ion source to maintain the source material in a liquid state, if this is so, the heating may be achieved by any convenient method. In particular, when the ion source is used as a thruster in an artificial satellite, solar radiation may be used as the heat source. Alternatively, electrical resistance heating can be used, either by passing an electric current through the ion source itself, or by means of a separate heater winding surrounding the ion source. Such heating particularly may be necessary when the ion source is used to supply metal ions for use in connection with processes such as ion bombardment, cleaning, sputtering, or ion implantation.

WHAT WE CLAIM IS:—

1. A field emission ion source, comprising an array of emitting points, a reservoir for a liquid source material for ions to be emitted, and a plurality of capillary feel channels for supplying the liquid source material to the emitting points.

2. A field emission ion source according to claim 1, wherein the array of emitting points is a linear array.

3. A field emission ion source according to Claim 1 or Claim 2, wherein the array is formed by a plurality of closely packed pointed wires and the capillary feed channels are provided by the interstices between the wires.

4. A field emission ion source according to claim 1 or claim 2, wherein the array is provided by at least one metal sheet an edge of which is formed to provide the emitting points and the capillary feed channels are provided by grooves formed in the surfaces of the sheet.

5. A field emission ion source according to any preceding claims, wherein the reservoir is formed by the total volume of the capillary feed channels.

6. A field emission ion source according to any preceding claim, including means for heating the reservoir to maintain the material in a liquid state.

7. A field emission ion source substantially as hereinbefore described with reference to the drawings accompanying the provisional specification.

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1 SHEET

PROVISIONAL SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale.

Fig. 1.

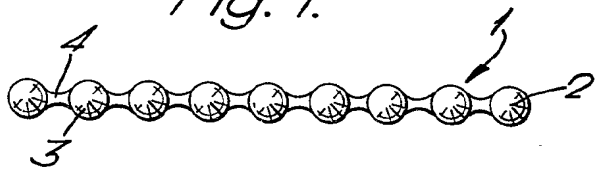

Fig. 2.